

MEMORANDUM

SUBJECT: Boiling Water Time for Killing Pathogens

FROM: James R. Elder, Director  
Office of Ground Water and Drinking Water

TO: Drinking Water Branch Chiefs, Regions I X

I am attaching an article from the Morbidity and Mortality, Weekly Report (September 18, 1994), on the boil water advisory issued during December 1993 for Washington, DC. The last paragraph of this article includes a joint EPA/Centers for Disease Control policy statement on how long individuals should boil their water when a water system issues a boil water notice.

The statement recommends that individuals bring their water to a rolling boil for one minute. This will kill all known waterborne pathogens, including Giardia and Cryptosporidium. Because the boiling point is lower at higher altitudes, and thermal death information is not complete for all waterborne viruses, the policy statements recommends that individuals at elevations above 2 kilometers (6562 feet) boil their water for three minutes as a precaution.

Please convey this information to your States.

Attachment

Morbidity and Mortality Weekly Report  
September 16, 1994 Vol. 43 No. 36  
Pp. 661-669.

Epidemiologic Notes and Reports

**Assessment of Inadequately Filtered Public Drinking Water -  
Washington, D.C., December 1993**

The risk for waterborne infectious diseases increases where filtration and other standard water treatment measures fall. On December 6, 1993, water-treatment plant operators in the District of Columbia (DC) began to have difficulty maintaining optimal filter effectiveness. On December 7, filter performance worsened, and levels of turbidity (i.e., small suspended particles) exceeded those permitted by U.S. Environmental Protection Agency (EPA) standards. On December 8, DC residents were advised to boil water intended for drinking because of high Municipal water turbidity that may have included microbial contaminants. Although adequate chlorination of the DC municipal water was maintained throughout the period of increased turbidity, the parasite *Cryptosporidium parvum* is highly resistant to chlorination. Because of the increased risk for infection with this organism and other enteric pathogens, the DC Commission of Public Health and CDC conducted four investigations to determine whether excess cases of diarrheal illness occurred because residents drank inadequately filtered water. This report describes the results of these investigations.

The investigations included a random-digit-dialed telephone survey of DC residents and retrospective reviews of records from nursing homes, and seven hospital microbiology laboratories. The occurrence of diarrheal illness or presence of organisms in stool during the two weeks before the turbidity violation (period 1: November 22 - December 5) was compared with that during the 2-3 weeks after the violation was first noted (period 2: December 6 - December 21 or 26). The incubation period for cryptosporidiosis typically ranges from 2 to 14 days.

**Telephone survey.** The telephone survey sampled 1197 household members (0.2% of DC's 600,000 residents) from 462 households in all 22 DC residential ZIP code areas. The percentage of persons who reported having diarrhea (i.e., three or more loose or watery stools in a 24 hour period) were similar for period 1 (the reference period) and period 2 (2.8% versus 3.5%, respectively, relative risk [RR]=1.2; 95% confidence interval [CI]=0.8 - 1.9). A total of 37% of persons reported that bottled water was their principal source of drinking water at home, and 30% reported that bottled water was their primary source of drinking water both at home and at work. For both periods, reported use of bottled water was similar for persons with and without diarrhea.

**Hospital emergency department survey.** During the two periods, totals of 2140 (period 1) and 3315 (period 2) persons were evaluated at two DC hospital emergency departments. Medical

records were reviewed for all persons with diagnoses suggestive of gastrointestinal illness<sup>a</sup> (104 and 211 persons for Periods 1 and 2, respectively). The percentage of all persons who had diarrhea recorded in their emergency department charts was similar for periods 1 and 2 (1.5% versus 2.0%; RR=1.3; 95% CI=0.9 - 2.0). For both periods, approximately 70% of patients with diarrheal illness were DC residents. The percentages of stool specimens that were Positive for enteric pathogens (i.e., bacteria, parasites, or rotavirus antigen) were similar for the two periods. During each period, two stool specimens were examined for *Cryptosporidium*: none were positive during period 1, and one was positive during period 2.

**Nursing home survey.** Medical records were reviewed for all 443 residents from two selected nursing homes (14% of the 3156 nursing home beds in DC). During both periods, the mean numbers of bowel movements per person per day were 1.3. In addition, the daily mean number of residents with loose or large volume bowel movements were similar (27.1 and 27.8 persons for periods 1 and 2), and antidiarrheal medications were given at the same rate (0.002 doses per person per day) during both periods.

**Microbiology laboratory survey.** Data were obtained from microbiology laboratories of seven (64%) of the 11 DC hospitals. Although the total number of stool specimens examined for *Cryptosporidium* increased from period 1 (32 specimens) to period 2 (54 specimens), the percentage positive was lower but not statistically different for period 2 (12.5% versus 7.4%; RR= 0.6; 95% CI= 0.2 - 2.2). The percentages of stools positive for other pathogens (i.e., bacteria, *Giardia lamblia*, and rotavirus antigen) were similar for both periods.

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**Editorial Note:** To ensure safe municipal drinking water supplies, water treatment programs employ multiple barriers to prevent contaminants from reaching the consumer. These barriers include protection of the watershed, chemical disinfection, and filtration of surface water supplies such as lakes and rivers. When one of these barriers is absent or fails, the risk for waterborne disease may increase. The failure of the filtration process in DC prompted particular concerns about contamination with and exposure to *Cryptosporidium*.

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<sup>a</sup> Gastroenteritis, diarrhea, nausea, vomiting, gastritis, viral syndrome, dehydration, and hyperemesis gravidarum.

Outbreaks of cryptosporidiosis resulting from surface water contamination have occurred when turbidity was 0.9 - 2.0 nephelometric turbidity units (NTU)<sup>b</sup>. For example, in a waterborne outbreak in Milwaukee in 1993, a peak turbidity of 1.7 NTU was associated with illness in approximately 400,000 persons (1). In DC, the turbidity levels reached 9.0 NTU.

Because *Cryptosporidium* is highly resistant to chlorination, disinfection of water is not a reliable method for preventing exposure to it. The failure to detect increased rates of illness among residents of DC probably reflects the absence of, or presence of only a small number of, oocysts in the water that supplied the municipal water treatment plant at the time the filtration failure occurred. In addition, the investigations in DC did not detect any increase in diarrheal illness associated with the elevated water turbidity; however, the sample sizes in these investigations were too small to rule out low level transmission of waterborne agents. For example, the telephone survey probably would not have detected an outbreak affecting fewer than 12,000 persons.

*Cryptosporidium* is present in 65% - 87% of surface water samples tested throughout the United States (2,3). However, because current techniques to detect *Cryptosporidium* in water are cumbersome, costly, and insensitive, tests to detect it are not routinely performed by water utilities. During 1995, EPA plans to collect additional information about *Cryptosporidium* and other microorganisms in surface water used by municipal water treatment facilities in the United States and to assess the effectiveness of water treatment methods for removing them.<sup>c</sup>

The early detection of waterborne outbreaks of cryptosporidiosis is difficult for at least four reasons: 1) many physicians are unaware that *Cryptosporidium* can cause watery diarrhea; 2) the symptom complex often resembles a viral syndrome; 3) clinical laboratories often do not routinely test for *Cryptosporidium* when a physician requests a stool examination for ova and parasites; and 4) few states include cryptosporidiosis as a reportable disease.

Variations in recommendations regarding the duration of boiling during boil water advisories have reflected uncertainty about how long some organisms can survive. On the basis of a recent literature review, CDC and EPA recommend that water be rendered microbiologically safe for drinking by bringing it to a rolling boil for 1 minute; this will inactivate all major waterborne bacterial pathogens (i.e., *Vibrio cholerae*, enterotoxigenic *Escherichia coli*, *Salmonella*, *Shigella sonnei*, *Campylobacter jejuni*, *Yersinia enterocolitica*, and *Legionella pneumophila*) and waterborne protozoa (e.g., *Cryptosporidium parvum*, *Giardia lamblia*, and *Entamoeba histolytica* [4 - 7]). Although information about thermal inactivation is incomplete for waterborne viral pathogens, hepatitis

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<sup>b</sup> The American Waterworks Association encourages water utilities to maintain turbidity measurements of water as it leaves the treatment plant at or below 0.1 NTU.

<sup>c</sup>59 FR 6332.

A virus - considered one of the more heat resistant waterborne viruses (8) - also is rendered noninfectious by boiling for 1 minute (9). If viral pathogens are suspected in drinking water in communities at elevations above 6562 ft (2 km), the boiling time should be extended to 3 minutes.

### References

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